IDENTIFICATION OF DATA CONTENT BASED ON MEASUREMENT OF QUALITY OF PERFORMANCE

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Introduction

Increasing the quality of production belongs to management goals of every single business, whether production means products or services providing. Better quality of production results in, for example, gaining competitive advantage on the market, effective territorial management, returning customer, and citizen satisfied with public administration services and others. Management drives for better quality and resulting profitability in financial and non-financial measures. Management of business processes requires supporting business data; business processes and business data form a linked unit, because business processes need relevant data for work and business data should fully serve to business processes. Suitable information environment is, therefore, a necessary condition for successful existence of an organization.

Change of business information environment, thus changes in information systems, is difficult but necessary. Difficulty arises from the complexity of system changes development as such and financial costs associated with them. Necessity arises from changes in business processes. These business processes changes are caused by efforts to achieve better organization performance and also changes in business processes result from the reaction of the organization to external and internal influences. Internal effects result from adaptation on given business process which means that workers have fully adopted the process and they are finding ways to, for instance, speed-up activities; reduce delays between consecutive activities or another process improvement; outer effects are caused by changes in requirements from customers' side, changes in suppliers' attitude, changes in legislation and others; all of these changes have to lead to improvement of the process, thus to change in process as a reaction to requirements and effects stated. Questions are - To what extent the information environment of the firm supports performance of business processes? How fast is the information environment of firms able to respond to changes in business processes? Is the information environment able to assist companies to achieve better quality and better performance of business processes?

1. Evaluation of Business / Organization Performance

A significant part of process management is the evaluation of business /organization output. Application of methods for monitoring organization output and for production quality assessment is considered a necessity if an organization wants to reach good output in long term. Methods of evaluation of quality and efficiency have found their place in both private and public sector. It is often such time sequence when a certain management method is used first in a production organization and then it is used in a non-production organization as a method proven in practice. Even though there are differences between managements of both sectors, basic principles of management activities are the same in both sectors. That is why the same or very similar models and methods can be used for process management and for evaluation of processes output in both sectors.

Models of success and models of exceptionality belong among frequently used methods. They are based on evaluation according to determined criteria and are often connected to

awarding the best organizations in given branch. Individual criteria of models should represent important areas which lead to prosperity of organizations. One of these models is Excellence Model (EFQM) [6] and model Common Assessment Framework (CAF) for improving an organization through self-assessment [7]. CAF model is derived from model EFQM and is transformed to specific public administration needs.

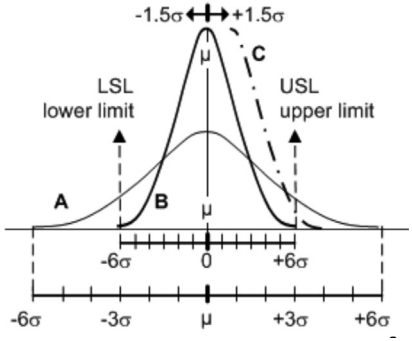
Both models have the same basic principles which include [21]:

- Process and system approach: process approach is considered to be the base of success, because all organization activities are realized in processes; and in processes the added value is created. Process management is not only about measuring and monitoring of certain measurable parameters; it also includes constant evaluation of processes and their improvement.
- Decision-making based on facts: in order to make decision efficient it is necessary to have needed information which has to be found, verified for validity, analyzed and then solutions have to be designed with the help of the information. Fundamental roles in this process are played by information technologies and business information systems.

The methods and their principles have different application in, e.g. development of software for quality evaluation based on EFQM [10]. Among other methods of managing and improving quality we can name methods Six Sigma and Kaizen. Both these methods are focused mainly on economic organizations and again they follow the principles of EFQM. Kaizen is approach of continuous improvements; it is about continuous flow of little / partial improvements at all organization levels [11], [23]. The Six Sigma method is focused on the improvement of quality with emphasis on elimination of defects. The fundamental idea of this method is the effort to a perfect production [14], [16], [17], i.e. avoid mistakes. Mistake is comprehended as any discrepancy with customer's wish; or simply any case when the customer is dissatisfied (external or internal customer). Based on customer's requests on product and organization requests we can define quality criteria Critical to Quality (CTQ). Six Sigma can be defined as a methodology to manage process variations that cause defects, defined as unacceptable deviation from the mean or target; and to systematically work towards managing variation to eliminate those defects [16].

The method uses the normal distribution curve that describes how probability is distributed; Sigma is determined as standard deviation. Principle of the method is illustrated in figure 1. The base of it are limits which are determined based on customer's requests – upper specification limit (USL) and lower specification limit (LSL); the area inside limits represents suitable production / output, the area outside limits represents unsuitable (defective) outputs, mean value μ represents ideal production without deviations. In the initial situation A performance of process and compliance of limits proceeds in such a way that USL (upper specification limit) and LSL (lower specification limit) have distance of 3 sigma from mean value μ. If there is ideal improvement in the organization, then the organization transforms production conditions to situation B (output of process and limit compliance proceeds in such way that USL and LSL have a distance of 6 sigma). Model Six Sigma considers also circumstance when mean value is in real situation shifted by +- 1.5 sigma (in the picture it is represented by situation C).

Fig. 1: Principles of Six Sigma Approach



Source: [14], own adaptation

In accordance with the Six Sigma method, defects are monitored and are the base for calculation of DPMO (Defects Per Million

Opportunities); the value DPMO is the base for determination of sigma level by means of the conversion table.

Methods recommend using subjective (soft) and objective (hard, measurable) indicators, of course, with accent on objective indicators and objective evaluation processes. The choice of appropriate indicators for measuring and evaluation of relevant business data is a key factor for measurement of quality and performance of business process and, therefore, it forms the basis for process improvement.

2. Relevance of Business Data

Information systems are fully intended to support business processes. In order to gain this functionality, two aspects are monitored, the content and the security of information system [18]. Different approaches or frameworks of business information management aim to contribute to solving this topic. Business Intelligence approach is an umbrella term that combines architectures, tools, databases, analytical tools, applications, and methodologies. Its major objective is to enable interactive access to data, to enable manipulation of data, and to give business managers and analysts the ability to conduct appropriate analysis. By analyzing historical and current data, situations, and performances, decision makers get valuable insights that enable them to make more informed and better decisions. The process of business intelligence is based on the transformation of data to information, then to decisions, and finally to actions [13], [19]. The approach of Competitive intelligence is the art of defining, gathering, analyzing, and distributing intelligence about products, customers, competitors, individuals, concepts, information, ideas or data needed to support executives and managers in making strategic decisions for an organization; includes a broad array from government intelligence to market intelligence to business intelligence; the purpose is to focus not only on business information [2], [3]. The approach of Computer Intelligence expresses the topic of quality computing platforms; this is the application of software tools to support decision making and management, scientific procedures that apply computational intelligence [1].

Managing of company informatics can be performed with the support of a certain framework or model; Information Technology Infrastructure Library (ITIL) and COBIT belong among standards. ITIL is a framework mostly for company IT management, and provides it with instructions, templates, diagrams and other proven methods for IT services managing [4], [9], [20].

The ITIL framework consists of recommendations, proven sequences, templates and manuals within interest areas as IT strategy, services proposals, services operations and continuous improvement of IT services. COBIT is a framework and supporting tool set that allows managers to bridge the gap with respect to control requirements, technical issues and business risks, and communicate that level of control to stakeholders [8]; COBIT enables the development of clear policies and good practice for IT control throughout enterprises.

These approaches and frameworks are particularly concerned with data manipulation (the aim is effective data manipulation in order to business processes) and solve mostly management of IT processes in order to support business processes and meeting business objectives. It is obviously important, because the quality of information system is given by its contribution to performance and effectiveness of company processes, activities and particular users [12], [22]. The quality of information system is, therefore, perceived in wider context because it is important to which extent the business processes and business goals are supported by data and performance of concrete application.

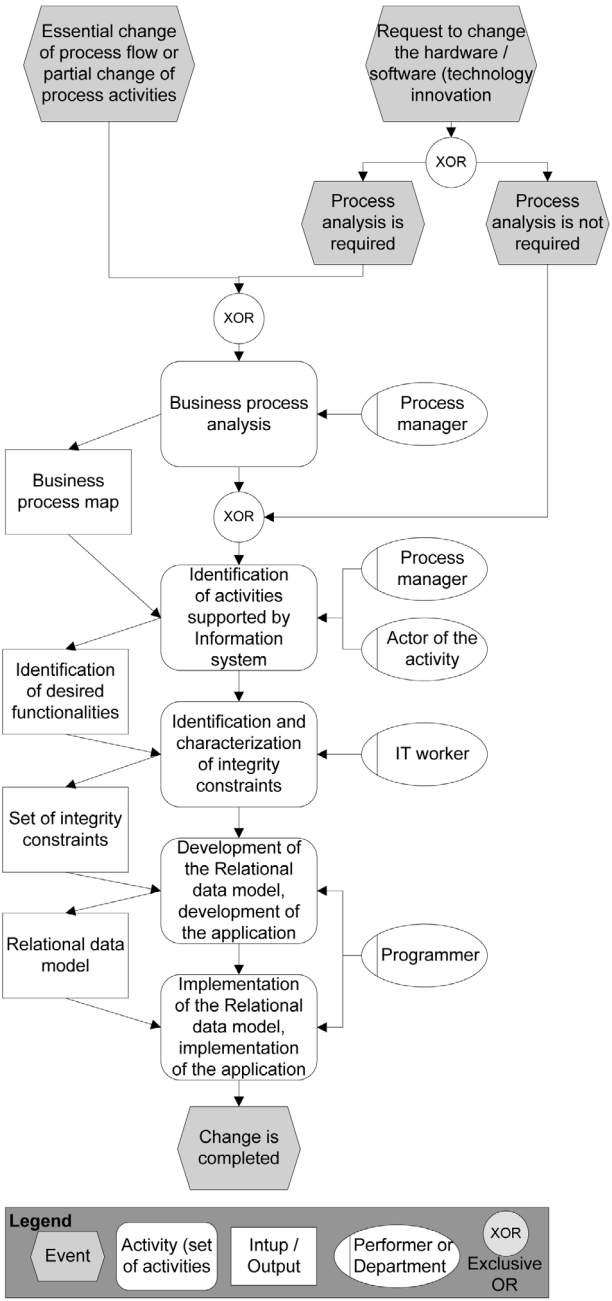
Business processes need support of an information system, which means support of IT applications with relevant data. The information systems are most often realised by means of database software. It is above all a case of transaction database systems that are designed for work with organisation's operative data. Data model is in business practice almost exclusively implemented using the relational data model; the basic construct is a relation.

Scheme for the relation titled R can be expressed as [5]:

$$R\ (A1{:}D1,\ A2{:}D2,\ldots,\ An{:}Dn) \qquad (1)$$

where $Di = dom(Ai)$, for $i \in \langle 1,n \rangle$; A means an attribute; D means domain of attribute.

Fig. 2: **Procedure for Change of the Relational Data Model in the Context of Process Changes**



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A domain describes the set of possible values for a given attribute, and can be considered a constraint on the value of the attribute. Domains and other integrity constrains (data types, correctness conditions, etc.) are an integral part of the relational model.

Scheme for the relational model can be expresses as [15]:

$$R = \{ (R1:I1),\ldots, (RK:IK); I\} \quad (2)$$

where Ri means the relation, Ii means the integrity constraint for $i \in <1,n>$; I means global integrity constraints for all relationships among relations.

Development of e relational data model is based on the transformation of the analytical models in the process of data modelling.

Changing the relational data model, respectively change in the information system is initiated by two situations (events):

- Changes in the business process: essential change of process flow or partial change of process activities;
- Request to change the hardware / software: it is the innovation of technology, use of new ICT opportunities.

Procedure for change of the relational data model in the context of process changes is expressed in Figure 2.

The model captures major activities in connection with the identification of relevant business data:

- Identification of activities supported by the information system: selected activities expressed in a process map have to be supported by information system;
- Identification and characterization of integrity constraints: data integrity, domain integrity, referential integrity etc., these constraints are important and essential input for creating a relational data model.

This procedure (see Figure 2), however, is not related to the continuous process improvement, respectively it is not related to the measurement of process performance quality in order to constantly improve the process.

3. Identification of Data Content Based on Measurement of Quality of Performance

To measure the quality of production performance is important to select the measured indicators appropriately and also to monitor and evaluate them appropriately.

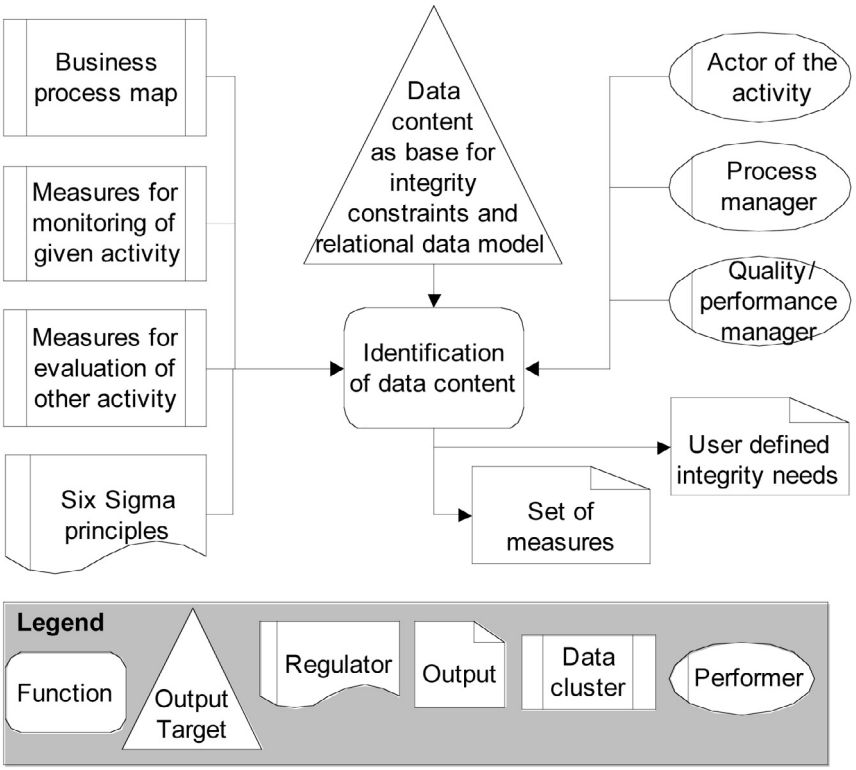
For monitoring it is necessary to take into account the characteristics of each instance of process.

- Variability among process instances: most instances within one process proceed in usual way, but some instances have unusual course, which occurs rarely; these seldom instances then distort total results.
- Various periodicities in repeating of instances: character of the process can be such that its instances are performed regularly and distributed across the year. Measuring of length i.e. of 6 months then fully describes conditions during the whole year. The instances of the other process are performed unevenly during the year, i.e. in some regular periods of time there are plenty of instances and another time period there are only a few instances. Measuring randomly may fall into a period with few instances, which – again – distorts the results.

Other characteristics related to indicators:

- Correct structure of indicators: it is vital to find as many indicators as possible and such indicators that their evaluation would have predicative ability – so that the evaluation really reflects the quality or defectiveness of production.
- Objective and subjective indicators: the main question is when and to what extend it is suitable to use subjective indicators, or whether it is more suitable to focus on objective indicators.
- Precision of recorded values of indicators: The indicators can be monitored systematically (using appropriate technology) or unsystematically (personal recording values). Personal recording represents the risk that the indicators are not consistently recorded and the workers interpret them later with a different meaning.

Fig. 3: Context Model of the Functionality – Identification of Data Content



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It is a complex task to find suitable indicators, monitor them and evaluate them. Principle basis of Six Sigma methods appears to be suitable for use both - in manufacturing organizations, and in services (e.g. organization of public administration). Monitored characteristics are defect opportunities as well as defects themselves. Defect (mistake) is comprehended as any discrepancy with customer's wish; or simply any case when the customer is dissatisfied (external or internal customer).

Method is based on mathematical statistical apparatus. Calculations according to the Six Sigma method:

Defects Per Unit
DPU = Total Number of Defects/Total number of Product Units (3)

Defects Per Opportunity
DPO = Total Number of Defects x TO (4)

where Total Opportunities
TO = Total number of Product Units x Opportunities (5)

Defects Per Million Opportunities
DPMO = DPO x 1.000.000 (6)

The DPMO value is, according to conversion table, converted to sigma expression / level. The value of sigma level is the starting point for improving of the process and in this way for obtaining of higher value of six sigma level.

Selection of appropriate indicators is emphasized; it is suitable to find maximum

number of locations which could be monitored as defect opportunities. Monitored and evaluated values of the indicators tell us about the quality of individual performance, given work activities. There may be two situations:

- The indicators provide information about the quality of performance of work activities within which the defects were measured.
- The indicators provide information about the quality of the performance of another work activity, so product unit is formed in a given work activity and values for assessing the quality of this product unit are measured in another work activity (activities).

As a system solution it appears that the indicators should to be involved into business information systems. Therefore, determination of user requirements (by means of data content identification) has to precede the analysis and development of the relational data model.

Context for the idea of identification of data content is shown in Figure 3. It is necessary to take into account the characteristics:

- Data content must be identified for each business activity (within the process) that is to be supported by information system module.
- More participants are involved in identifying data content of the functionality:
  - Actor of the activity characterizes demands on the data for given IS module in terms of performance of his/her profession;
  - Process manager characterizes demands on the data for that IS module in terms of management of the process (modelled work activity occurs in this process);
  - Quality manager characterizes demands on the data for that IS module in terms of quality management of this process and others processes (it means other work activities).
- Output is defined by a set of integrity requirements, which includes data requirements in connection with the performance of the process activities and data requirements in relation to the measurement and evaluation of quality of performance of the process (i.e. the quality of given business activity and quality of other activities);
- Purpose of data content identification is to identify the requirements that become an input for the development of an information system, respectively for the development of the module information system; information system (designed this way) will contain not only the data needed to support given work activity, but also the data necessary for assessing the quality of the performance of given work activities and other work activities.

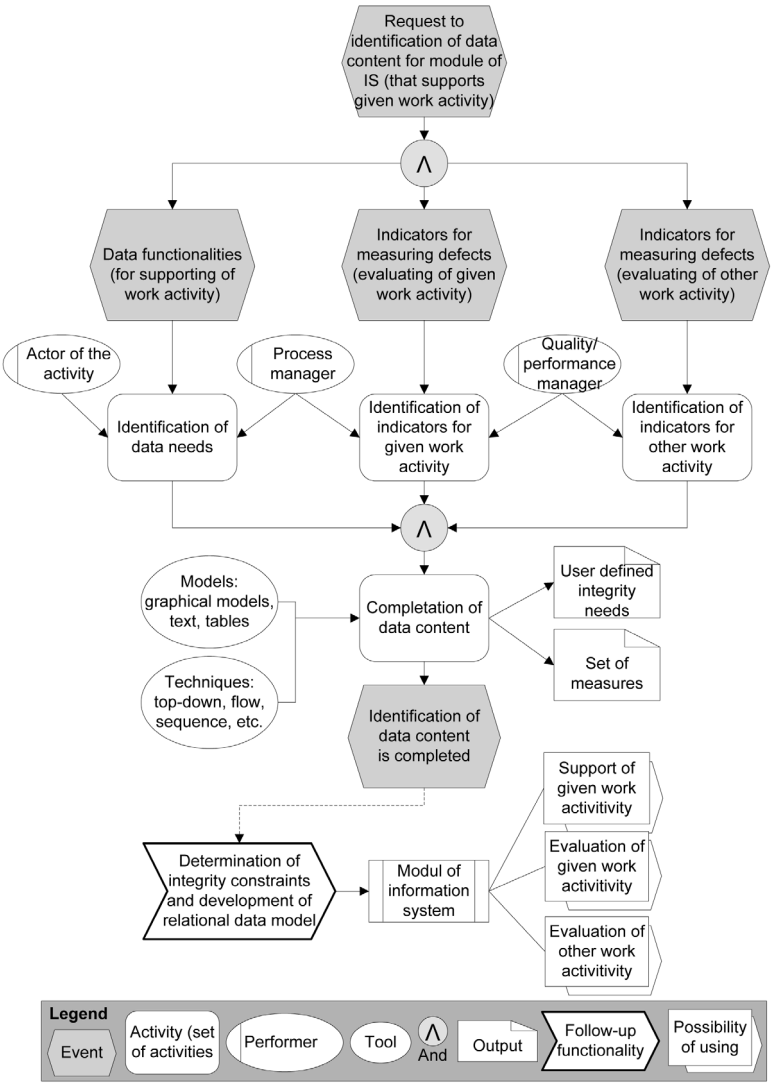
How to identify the data content is expressed in Figure 4. Identification of data content consists of identifying three groups of data functionalities that are associated with analyzed work activity and thus also with analyzed module of information system:

- Determination of data needs for the actual performance of work activity in accordance with a process map of the process;
- Determination of data needs for defects measuring and for measuring of defect opportunities (indicators are based on the principles of Six Sigma method) in order to measure the quality of performance of the given work activity; i.e. data arise in connection with that activity and is used to measure quality of performance of the same work activity;
- Determination of data needs for defects measuring and for measuring of defect opportunities (indicators are based on the principles of Six Sigma method) in order to measure the quality of performance of another work activity; i.e. data arise in connection with that activity and is used to measure quality of performance of another/different work activity.

Various modelling techniques can be used for formal expression of data content. The technique determines how to reach the needed results; variation of decision making in different situations and what arises from it, it defines the sphere of force etc. As modelling techniques can be used the 'top-down decomposition' technique for the decomposition of the problem area to lower – more detailed levels, the 'down-top composition' technique for composition of the details to the higher superior units; the 'functional follow up' technique for expressing the partial elements which follow functionally to each other, the 'sequence' technique for expression the sequence and follow up the

elements in time, the 'elements communication' technique for a closer identification of the parts and their integration in the unit, the 'global delimitation of the unit' technique for the delimitation of the all important features which influence the element and are also necessary for realization of the element, the 'detailed delimitation of the content' technique for detailed description of the inner parts of given element, the 'delimitation of the functionality' technique to specify the characteristics of the asked functionalities, the 'watching the data flow' technique for watching the data flows within the given problem area, the 'watching the event influencing the problem area' technique for identification important events and their influences to the elements of the problem area, and others.

Fig. 4: Identification of Data Content



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For identification of data content more modelling techniques are used – models are complementary. E.g. interconnection of the context view and detailed sequence means the interconnection of the two techniques, i.e. the element is characterized by the view of 'outside' (contextual delimitation) and then its 'inner' side is described in detail (detailed delimitation), where the objects appearing in the contextual view must also have a role in the detailed delimitation. Similarly in delimitation of the functionality the user processes the topic as if the result of the solution was the offered functionality which is needed by the user or another target group; therefore the precise characteristic of 'what I ask for', i.e. the precise characteristic of the asked functionalities is necessary and one of the initial steps of the analyses; functionality can be delimited firstly by global and then by detailed delimitation.

These techniques are to be applied using graphic and text tools. This may be the diagrams that are part of established modelling procedures, i.e. it is possible to use the graphical data modelling tools and the graphical process modelling tools. However, it is not necessary to use graphical tools belonging to the standards; it is just possible to use your own method of graphic expression.

Conclusion

Managed business processes and data aimed at them from information systems significantly participate on fulfilling of business goals. Cohesion of business processes and data consists in the fact that in order for management of processes to be correct, relevant information is necessary and simultaneously business information systems have to contain such data, which serve for execution of business processes and support them. Business processes and their suitable data are closely related and constitute a coherent complex. Changes in the business process cause the need for changes in the relevant information system. Character of businesses processes changes and data changes are participated by process managers and actors. They know precisely and can define which activities are performed in what succession, what kind of data and in what format they are needed etc.

The information system should also support another important functionality; it should support measurement of the performance quality of the work activity and the business process as a whole. To measure quality of performance, it is appropriate to use the principles of the Six Sigma method. The method evaluates defects in relation to defect opportunities. For Six Sigma utilization it is necessary to identify indicators by which defects are evaluated. An important factor is appropriate measurement of these values, thus determining which indicators should be measured and how they should be recorded. Indicators for measuring defects and opportunities for defects must become a part of the information system. It follows that changes in the structure of indicators or changes in the format of indicators cause the need for changes in the relevant information system. Character of these changes is participated by process managers and quality managers. The data of the given module of information system data performs more functions; it serves not only for the actor (worker) to support their work activities within the business process. Another function of the information system should be - to provide data that can be used for assessing the quality of the performance of work activities and for assessing the quality of performance of the business process as a whole. It expands the requirements on developed / altered module of information system.

The current typical data architecture is relational, based on the relational data model. The development of the relational data model represents a set of specialized knowledge, application methods of data modelling, including definitions of integrity constraints; this expertise is relevant for members of the technology development team. Direct involvement of actors in the development of a data model is not realistic as it is not possible to delegate to them the expertise associated with the development of relational data model. However, only they know the best what they want and need in order to improve quality and fulfil company goals; only they can, in some way, express their requirements and needs.

Therefore, identification of data content must precede the development of the given module of information system. The definition of data content should include these areas: identification of indicators for measuring quality

of performance of given work activities and the business process, identification of indicators for measuring quality of performance of other business processes, identification of data objects within the desired functionality, identification of links between indicators and links between data objects, etc. Actors, process managers and quality managers use data delimitation to describe accurately their data requirements that they need to perform their business activities. Only in this way, managers will receive tools in form of information systems that provide them with information relevant to business processes.

References

[1] ALTER, S. *Information Systems*. Upper Saddle River: Prentice Hall, 2002. 286 p. ISBN 0-8493-1661-8.

[2] BASL, J., et al. *Podnikové informační systémy: podnik v informační společnosti*. Praha: Grada, 2008. 283 p. ISBN 978-80-247-2279-5.

[3] BRÁZDILOVÁ, M. Konkurenční zpravodajství a konkurenceschopnost podniků. *E+M Ekonomie a Management*. 2005, Vol. 10, Iss. 4, pp. 47-53. ISSN 1212-3609.

[4] CARTLIDGE, A., et al. *Úvodní přehled ITILrV3*. Prag: Hewlett-Packard s.r.o., 2007. 56 p. ISBN 0-95551245-8-1.

[5] DATE, C. J. *An Introduction to Database Systems*. Boston: Addison-Wesley, 2004. 983 p. ISBN 0-321-19784-4.

[6] EFQM Excellence Model [online]. Brussles, c2011 [cit. 2011-09-09]. Available from: <http://www.efqm.org/en/tabid/ 108/default.aspx>.

[7] EIPA. CAF – Common Assessment Framework [online]. Maastricht, c2011 [cit. 2011-11-02]. Available from: <http://www.eipa.eu/en/pages/show/&tid=67>.

[8] IT Governance Institute. *COBIT 4.1*. USA: IT Governance Institute, 2007. 213 p. ISBN 1-933284-72-2.

[9] ITIL ® – IT Infrastructure Library [online]. [cit. 2011-10-10]. Available from: <http://www.itil-officialsite.com/AboutITIL/WhatisITIL.asp>.

[10] LEBA, M., et al. Software for Quality Evaluation Based on EFQM Excellence Model. In *International Conference on Applied Computer Science*. Malta, 2010. pp. 609-614. Available also from: <http://www.wseas.us/e-library/conferences/2010/Malta/ACS/ACS-98.pdf>. ISBN 978-960-474-225-7. ISSN 1792-4863.

[11] MASAAKI, I. *KAIZEN*. Brno: Computer Press, 2004. 272 p. ISBN 80-251-0461-3.

[12] MOLNAR, Z. *Efektivnost informačních systémů*. Praha: Grada, 2000. 142 p. ISBN 80-7169-410-X.

[13] NOVOTNÝ, O. et al. *Business Intelligence: Jak využít bohatství ve vašich datech*. Praha: Grada, 2005. 254 p. ISBN 80-247-1094-3.

[14] PANDE, P. S., et al. *Zavádíme metodu Six Sigma*. Brno: TwinsCom, 2002. 416 p. ISBN 80-238-9289-4.

[15] POKORNÝ, J., et al. *Databázové systémy*. Praha: Vydavatelství ČVUT, 2003. 148 p. ISBN 80-01-02789-9.

[16] SIX SIGMA. *About Six Sigma* [online]. [cit. 2011-10-25]. Available from: <http://www.sixsigmaplus.nl/aboutsixsigma.asp>.

[17] SKOPEČKOVÁ, H. et al. Subjective and Objective Metrics for Selfevaluation of Public Administration Organization. In *International journal of mathematical models and methods in applied sciences*. Malta: NAUN-Press, 2011. Iss. 1, Vol. 5, pp. 48-58. ISSN 1998-0140.

[18] ŠIMONOVÁ, S. et al. Proactive IT / IS Monitoring for Business Continuity Planning. *E+M Ekonomie a Management*. 2011, Vol. 14, Iss. 3, pp. 57-65. ISSN 1212-3609.

[19] TURBAN, E. et al. *Business Intelligence: A Managerial Approach*. New Jersey: Prentice Hall, 2011. 312 p. ISBN 0-13-610066-X.

[20] VRANA, I. et al. *Zásady a postupy zavádění podnikových informačních systémů*. Praha: Grada, 2005. 188 p. ISBN 80-247-1103-6.

[21] VEBER, J. et al. *Management kvality, environmentu a bezpečnosti práce*. Praha: Management Press, 2006. 358 p. ISBN 80-7261-146-1.

[22] ZAVADILOVA, I. et al. Modeling of Process of System Changes under Conditions of IT Applications Outsourcing. In *International journal of mathematical models and methods in applied sciences*. UNIVERSITY PRESS. 2011. Vol. 5, Iss. 3, pp. 314-323. ISSN 2074-1308.

[23] ZÁVODNÁ, L. S. Filozofie Kaizen ve sféře služeb. In STRIŠŠ, J. et al. (eds.) *Aktuálne marketingové trendy v teórii a praxi*. 1st Iss. Žilina: Edis, 2008, pp. 247-251. ISBN 978-80-8070-964-8.

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